JN3 Hardware User Guide

1vv0300984 Rev.2 – 2012-08-06

Making machines talk.

APPLICABILITY TABLE

PRODUCT
JN3

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1. Introduction

1.1. Scope

The JN3 is a 12.1mm by 15.9mm integrated GPS receiver module using SiRFstar IV technology. This document expands upon the data sheet(s) to highlight particular areas to allow the hardware engineer to achieve a successful design implementation.

1.2. Audience

This document is intended for helping customer in the integration of the Telit SL868 GPS module

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

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1.4. Document Organization

"Chapter 1: "Introduction" provides a scope for this document, target audience, contact and support information, and text conventions.

"Chapter 2: "Powering the SL868" gives an overview about power supply.

"Chapter 3: "Updating Firmware" describes the SW updating procedure for Flash version.

"Chapter 4: "Updating Patch code" describes how to apply patch code to ROM version.

"Chapter 5: "Main serial interface" describes the serial interface.

"Chapter 6: "MEMS sensor and EEPROM Interface" describes the DR I2C interface.

"Chapter 7: "RF Front End Design" describes in details the characteristics of the Front end.

"Chapter 8: "Reference Design" gives an overview about the reference design.

"Chapter 9: "Firmware configuration" describes the configuration settings.

"Chapter 10: "Handling and soldering" describes packaging and soldering of the module.

"Chapter 11: "PCB layout details" describes the mechanical design of the module.

"Chapter 12: "Safety recommendations" provides some safety recommendations that must be followed by the customer in the design of the application that makes use of the SL868.

"Chapter 13: "Document History" describes the history of the present product.

1.5. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

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All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.6. Related Documents

- JN3 Product Description,
- J-F2 EVK User Guide,

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2. Powering the JN3

2.1. 3.3V Supply Voltage

The JN3 is powered by applying 3.3 volts DC to the VCC_IN pin of the module. Internal regulators reduce the supply voltage to the nominal 1.8 volts DC required by the internal electronics.
The JN3 monitors the 3.3 volt supply and issues an internal hardware reset if the supply drops below 2.5 volts. This reset protects the memory from accidental writes during a power down condition. The reset also forces the JN3 into a keep-alive power state.
While this means the JN3 can work with a main supply voltage down to 2.5 volts DC, the 3.3 volt DC logic levels on the module output will also be scaled proportionally.
The JN3 module always powers up into the operate state without user intervention.

2.2. Battery Back-up

VBATT is applied to the module to keep the RTC running and battery backed RAM alive whenever main power is removed. This allows for faster startup upon reapplication of main power. If main power is removed, the flash based modules will draw approximately 40 uA from the input, whereas the EEPROM based modules will draw approximately 110 uA and the ROM-only devices will draw approximately 110 uA.
Internal diode OR'ing provides an internal source for VBATT even if this pin is not used.

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3. Updating the Firmware: Flash Module (ONLY)

During normal operations, the BOOT signal should be tied to ground through a 100K pulldown resistor. This will ensure the GPS module executes the code out of the internal flash memory.
However, if the internal flash memory needs to be updated, the following steps should be performed to place the JN3 module into a state suitable for programming the internal flash memory.

1. Remove all power to the module.
2. Pull the BOOT signal high through a 10K pull up resistor to +1.8 volts.

   Note: The BOOT signal is not 3.3 volt tolerant.
3. Apply main power.
4. Run the software utility to re-flash the JN3 module. Clearing the entire flash memory is strongly recommended prior to programming.
5. Upon successful completion of re-flashing, remove main power to the module for a minimum of 10 seconds.
6. Pull the BOOT signal low through a 100K pull down resistor to GND.
7. Apply main power to the JN3.
8. Verify the JN3 has returned to the normal operating state.

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4. Updating Patch Code: EEPROM and ROM modules with Host Memory

Modules with EEPROM and ROM-only designs using external Host memory support firmware patching. Firmware patches for the EEPROM module are stored inside the I2C serial EEPROM device. Firmware patches for the ROM-only module are stored externally using Host memory.
At power up, patches are retrieved from EEPROM and loaded into patch RAM. Firmware patches are accumulated into patch data files, which in turn are made available with descriptions of their contents and applicability. A patch data file is cumulative in that it includes firmware improvements and enhancements made available in previous patches. It may also include configuration settings that differ from the ROM defaults, as in the default UART baud rate, for example. The desired patch data file must be distributed to the end-user device where it may be accessed by the Host processor.
The Host processor in the end-user device is required to run software that sends patch data from the patch file to the module using OSP Patch Protocol messages over the host serial port. Example source code to assist in the implementation of a patch downloader on the Host processor is available. Note that the module must be operating in full power mode during the patching process. The patch contents are loaded into patch RAM on the module, where they remain as long as main power is maintained. This avoids the reloading of patches into patch RAM when the system resumes normal operation from a low power state such as hibernate. At the end of the patching process the module performs an internal reset and restart.

If main power is lost on the ROM-only module, the Host processor must re-send the patch data over the host serial port after the module is powered up. The Host processor can determine whether patch data must be sent to the module by polling the software version, which reflects the currently applied patch file version.

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5. Main Serial Interface

Upon power up, the JN3 will communicate using a standard asynchronous 8 bit protocol (UART) with messages appearing on the TX line, and commands and data being entered on the RX line. There is no parity bit, and no flow control operations are performed.

5.1. Input to the JN3

Maximum sustained inflow at the rate of command messages should not exceed about 10,000 characters per second. Above 115.2kbps, such as 1228800 bps (122880 characters per second), input flow should be limited to less than 10,000 characters/sec to keep from choking the system. Command processing is a low priority task within the system.

At higher data rates, TELIT recommends using OSP message/ACK protocol to prevent message loss.

Low data rates impact startup and TTFF values in sending configuration commands and patches to ROM-based devices and when using host storage for JN3 data files.

5.2. Output from the JN3

Users can control selection and rate of delivery of some output messages through OSP or NMEA configuration commands

Debug messages are controlled as a block and cannot be individually selected.

Some event or alarm messages occur spontaneously and cannot be directly controlled.

You must assess the capacity of the communications link between JN3 and the host. You must select OSP or NMEA messages appropriate to the application and well within the maximum capacity of the communications link. In assessing the capacity required, consider the protocol overheads and maximum size of variable payloads.

In power consumption-critical applications, any time spent creating and sending messages causes both the JN3 and the host to consume power. A low data link speed extends the current consumption of both host and JN3.

5.3. TX/RX Electrical

- “1” (mark) is logic high,
- “0” (space) is logic low,
- idle line = logic high,
- Line-break/open line is continuous logic low: (Continuous break is not allowed on RX during operation and not generated on TX during operation.)
- Do not drive the RX line HIGH if no power is applied to the module

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6. MEMS Sensor/EEPROM Interface

The DR I2C port is used for connecting to MEMS sensors, such as accelerometer or magnetometer. Pullup resistors of approximately 2.2Kohm to 1.8 volts are required on the SCL2 and SDA2 lines for proper operation.

Only an approved accelerometer (KIONIX part number KXTF9-4100, 3 x 3mm LGA 1.8V 3 axis accelerometer) can be used. The interrupt output of the accelerometer must be connected to GPIO4 of the JN3.

Data for the approved magnetic sensor (Aichi Steel part number AIM304, 3.5 x 4.0mm 3V 3-axis magnetometer) is output in OSP message 72.

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7. RF Front End Design

The JN3 contains an integrated LNA and pre-select SAW filter. This allows the JN3 to work well with a passive GPS antenna. If the antenna cannot be located near the JN3, then an active antenna (that is, an antenna with a low noise amplifier built in) can be used. The following items will be discussed in turn to assist in designing the “RF front end”.

1. RF signal requirements
2. GPS antenna polarization
3. GPS antenna gain
4. System noise floor
5. Active versus passive antenna
6. RF trace losses
7. Implications of the pre-select SAW filter
8. External LNA gain and Noise Figure
9. Powering the external LNA (active antenna)
10. RF interference
11. Shielding

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7.1. RF Signal Requirements

The JN3 can achieve Cold Start acquisition with a signal level of -147 dBm at its input. This means the JN3 can find the necessary satellites, download the necessary ephemeris data and compute the location within a 5 minute period. In the GPS signal acquisition process, downloading and decoding the data is the most difficult task, which is why Cold Start acquisition requires a higher signal level than navigation or tracking signal levels. For the purposes of this discussion, autonomous operation is assumed, which makes the Cold Start acquisition level the important design constraint. If assistance data in the form of time or ephemeris aiding is available, then even lower signal levels can be used to compute a navigation solution.
The GPS signal is defined by IS-GPS-200E. This document states that the signal level received by a linearly polarized antenna having 3 dBi gain will be a minimum of -130 dBm when the antenna is in the worst orientation and the satellite is 5 degrees or more above the horizon.
In actual practice, the GPS satellites are outputting slightly more power than specified by IS-GPS-200E, and the signal level typically goes higher as the satellites have higher elevation angles.
The JN3 will display a reported C/No of 40 dB-Hz for a signal level of -130 dBm into the RF input.
Each GPS satellite presents its own signal to the JN3, and best performance is obtained when the signal levels are between -125 dBm and -117 dBm. These received signal levels are determined by

- GPS satellite transmit power
- GPS satellite elevation and azimuth
- Free space path loss
- Extraneous path loss such as rain
- Partial or total path blockage such as foliage or building
- Multipath caused by signal reflection
- GPS antenna
- Signal path after the GPS antenna

The first three items in the list above are specified in IS-GPS-200E, readily available multiple sources online. IS-GPS-200E specifies a signal level minimum of -130 dBm will be presented to the receiver when using a linearly polarized antenna with 3 dBi gain.
The GPS signal is relatively immune to rainfall attenuation and does not really need to be considered.
However, the GPS signal is heavily influenced by attenuation due to foliage such as tree canopies, etc., as well as outright blockage caused by building, terrain or other items in the line of sight to the specific GPS satellite. This variable attenuation is highly dependent upon GPS satellite location. If enough satellites are blocked, say at a lower elevation, or all in a general direction, the geometry of the remaining satellites will result is a lower accuracy of position. The JN3 reports this geometry in the form of PDOP, HDOP and VDOP.
For example, in a vehicular application, the GPS antenna may be placed embedded into the dashboard or rear package tray of an automobile. The metal roof of the vehicle will cause significant blockage, plus any thermal coating applied to the vehicle glass can attenuate the

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GPS signal by as much as 15 dB. Again, both of these factors will affect the performance of the receiver.
Multipath is a phenomena where the signal from a particular satellite is reflected and is received by the GPS antenna in addition to or in place of the original line of sight signal. The multipath signal has a path length that is longer than the original line of sight path and can either attenuate the original signal, or if received in place of the original signal add additional error in determining a solution because the distance to the particular GPS satellite is actually longer than expected. It is this phenomena that makes GPS navigation in urban canyons (narrow roads surround by high rise buildings) so challenging. In general, the reflecting of the GPS signal causes the polarization to reverse. The implications of this are covered in the next section.

7.2. GPS Antenna Polarization

The GPS signal as broadcast is a right hand circularly polarized signal. The best antenna to receive the GPS signal is a right hand circularly (RHCP) polarized antenna. Remember that IS-GPS-200E specifies the receive power level with a linearly polarized antenna. A linearly polarized antenna will have 3 dB loss as compared to an RHCP antenna assuming the same antenna gain (specified in dBi and dBic respectively).
An RHCP antenna is better at rejecting multipath than a linearly polarized antenna. This is because the reflected signal changes polarization to LHCP, which would be rejected by the RHCP antenna by typically 20 dB or so. If the multipath signal is attenuating the line of sight signal, then the RHCP antenna would show a higher signal level than a linearly polarized antenna because the interfering signal is rejected.
However, in the case where the multipath signal is replacing the line of sight signal, such as in an urban canyon environment, then the number of satellites in view could drop below that needed to determine a 3D solution. This is a case where a bad signal may be better than no signal. The system designer needs to make tradeoffs in their application to determine which is the better choice.

7.3. GPS Antenna Gain

Antenna gain is defined as the extra signal power from the antenna as compared to a theoretical isotropic antenna (equally sensitive in all directions).
For example, a 25mm by 25m square patch antenna on a reference ground plane (usually 70mm by 70mm) will give an antenna gain at zenith of 5 dBic. A smaller 18mm by 18mm square patch on a reference ground plane (usually 50mm by 50mm) will give an antenna gain at zenith of 2 dBic.
While an antenna vendor will specify a nominal antenna gain (usually at zenith, or directly overhead) they should supply antenna pattern curves specifying gain as a function of elevation, and gain at a fixed elevation as a function of azimuth. Pay careful attention to the requirement to meet these specifications, such as ground plane required and any external matching components. Failure to follow these requirements could result in very poor antenna performance.
It is important to note that GPS antenna gain is not the same thing as external LNA gain. Most antenna vendors will specify these numbers separately, but some combine them into a single number. It is important to know both numbers when designing and evaluating the front end of a GPS receiver.
For example, antenna X has an antenna gain of 5 dBiC at azimuth and an LNA gain of 20 dB for a combined total of 25 dB. Antenna Y has an antenna gain of -5 dBiC at azimuth and an

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LNA gain of 30 dB for a combined total of 25 dB. However, in the system, antenna X will outperform antenna Y by about 10 dB (refer to Section 7.4 for more details on system noise floor).
An antenna with higher gain will generally outperform an antenna with lower gain. Once the signals are above about -130 dBm for a particular satellite, no improvement in performance would be gained. However, for those satellites that are below about -125 dBm, a higher gain antenna would improve the gain and improve the performance of the GPS receiver. In the case of really weak signals, a good antenna could mean the difference between being able to use a particular satellite signal or not.

7.4. System Noise Floor

As mentioned earlier, the JN3 will display a reported C/No of 40 dB-Hz for an input signal level of -130 dBm. The C/No number means the carrier (or signal) is 40 dB greater than the noise floor measured in a one Hz bandwidth. This is a standard method of measuring GPS receiver performance.
Thermal noise is -174 dBm/Hz at around room temperature. From this we can compute a system noise figure of 4 dB for the JN3. This noise figure consists of the loss of the pre-select SAW filter, the noise figure of the LNA as well as implementation losses within the digital signal processing unit.
If a good quality external LNA is used with the JN3, then the noise figure of that LNA (typically better than 1dB) could reduce the overall system noise figure of the JN3 from 4 dB to around 2 dB. Some of the factors in the system noise figure are implementation losses due to quantization and other factors and do not scale with improved front end noise figure.

7.5. Active versus Passive Antenna

If the GPS antenna is placed near the JN3 and the RF traces losses are not excessive (nominally 1 dB), then a passive antenna can be used. This would normally be the lowest cost option and most of the time the simplest to use. However, if the antenna needs to be located away from the JN3 then an active antenna may be required to obtain the best system performance. The active antenna has its own built in low noise amplifier to overcome RF trace or cable losses after the active antenna.
However, an active antenna has a low noise amplifier (LNA) with associated gain and noise figure. In addition, many active antennas have either a pre-select filter, a post-select filter, or both.

7.6. RF Trace Losses

RF Trace losses are difficult to estimate on a PCB without having the appropriate tables or RF simulation software to estimate what the losses would be. A good rule of thumb would be to keep the RF traces as short as possible, make sure they are 50 ohms impedance and don’t contain any sharp bends.

7.7. Implications of the Pre-select SAW Filter

The JN3 module contains a SAW filter used in a pre-select configuration with the built-in LNA, that is, the RF input of the JN3 ties directly into the SAW filter. Any circuit connected to the input of the JN3 would see complex impedance presented by the SAW filter, particularly out of band, rather than the relatively broad and flat return loss presented by the

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LNA. Filter devices pass the desired in band signal to the output, resulting in low reflected energy (good return loss), and reject the out of band signal by reflecting it back to the input, resulting in high reflected energy (bad return loss).
If an external amplifier is to be used with the JN3, the overall design should be checked for RF stability to prevent the external amplifier from oscillating. Amplifiers that are unconditionally stable at the output will be fine to use with the JN3.
If an external filter is to be connected directly to the JN3, care needs to be used in making sure neither the external filter nor the internal SAW filter performance is compromised. These components are typically specified to operate into 50 ohms impedance, which is generally true in band, but would not be true out of band. If there is extra gain associated with the external filter, then a 6 dB Pi or T resistive attenuator is suggested to improve the impedance match between the two components.

7.8. External LNA Gain and Noise Figure

The JN3 can be used with an external LNA such as what might be found in an active antenna. Because of the internal LNA, the overall gain (including signal losses past the external LNA) should not exceed 14 dB. Levels higher than that can affect the jamming detection capability of the JN3. If a higher gain LNA is used, either a resistive Pi or T attenuator can be inserted after the LNA to bring the gain down to 14 dB or the JN3 can be switched into a low gain mode by issuing an OSP command to do so.
The external LNA should have a noise figure better than 1 dB. This will give an overall system noise figure of around 2 dB assuming the LNA gain is 14 dB, or if higher the low gain mode is selected within the JN3.
The external LNA, if having no pre-select filter, needs to be able to handle other signals other than the GPS signal. These signals are typically at much higher levels. The amplifier needs to stay in the linear region when presented with these other signals. Again, the system designer needs to determine all of the unintended signals and their possible levels that can be presented and make sure the external LNA will not be driven into compression. If this were to happen, the GPS signal itself would start to be attenuated and the GPS performance would suffer.

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7.9. Powering the External LNA (active antenna)

The external LNA needs a source of power. Many of the active antennas accept a 3 volt or 5 volt DC voltage that is impressed upon the RF signal line. This voltage is not supplied by the JN3, but can be easily supplied by the host design.
Two approaches can be used. The first is to use an inductor to tie directly to the RF trace. This inductor should be at self resonance at L1 (1.57542 GHz) and should have good Q for low loss – the higher the Q, the lower the loss. The side of the inductor connecting to the antenna supply voltage should be bypassed to ground with a good quality RF capacitor, again operating at self resonance at the L1 frequency.
The second approach is to use a quarter-wave stub in place of the inductor. The length of the stub is designed to be exactly a quarter-wavelength, which has the effect of making an RF short at L1 at one end of the stub to appear as an RF open. The RF short is created by the good quality RF capacitor operating at self resonance.
The choice between the two would be determined by:

- RF path loss introduced by either the inductor or quarter wave stub.
- Cost of the inductor.
- Space availability for the quarter wave stub.

Simulations done by Telit show the following:

- Murata LQG15HS27NJ02 Inductor 0.65 dB of additional signal loss
- Quarter wave stub on FR4 0.59 dB of additional signal loss
- Coilcraft B09TJLC Inductor (used in ref. design) 0.37 dB of additional signal loss

This additional loss occurs after the LNA in the active antenna, so it is generally not significant unless the circuit is being designed to work with either an active or a passive antenna.

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7.10. RF Interference

RF Interference into the GPS receiver tends to be the biggest problem when determining why the system performance is not meeting expectations. As mentioned earlier, the GPS signals are at -130 dBm and lower. If signal higher than this are presented to the receiver it can be overwhelmed. The JN3 can reject up to 8 CW in-band jamming signals, but would still be affected by non-CW signals.
The most common source of interference is digital noise. This is created by the fast rise and fall times and high clock speeds of modern digital circuitry. For example, a popular netbook computer uses an Atom processor clocked at 1.6 GHz. This is only 25 MHz away from the GPS signal, and depending upon temperature of the SAW filter, can be within the passband of the GPS receiver. Because of the nature of the address and data lines, this would be broadband digital noise at a relatively high level.
Such devices are required to adhere to a regulatory standard for emissions such as FCC Part 15 Subpart J Class B or CISPR 22. However, these regulatory emission levels are far higher than the GPS signal.

7.11. Shielding

Shielding the RF circuitry generally is ineffective because the interference is getting into the GPS antenna itself, the most sensitive portion of the RF path. The antenna cannot be shielded because then it can't receive the GPS signals.
There are two solutions, one is to move the antenna away from the source of interference or the second is to shield the digital interference to prevent it from getting to the antenna.

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8. Reference Design

The JN3 Reference Design is presented in the figure below.

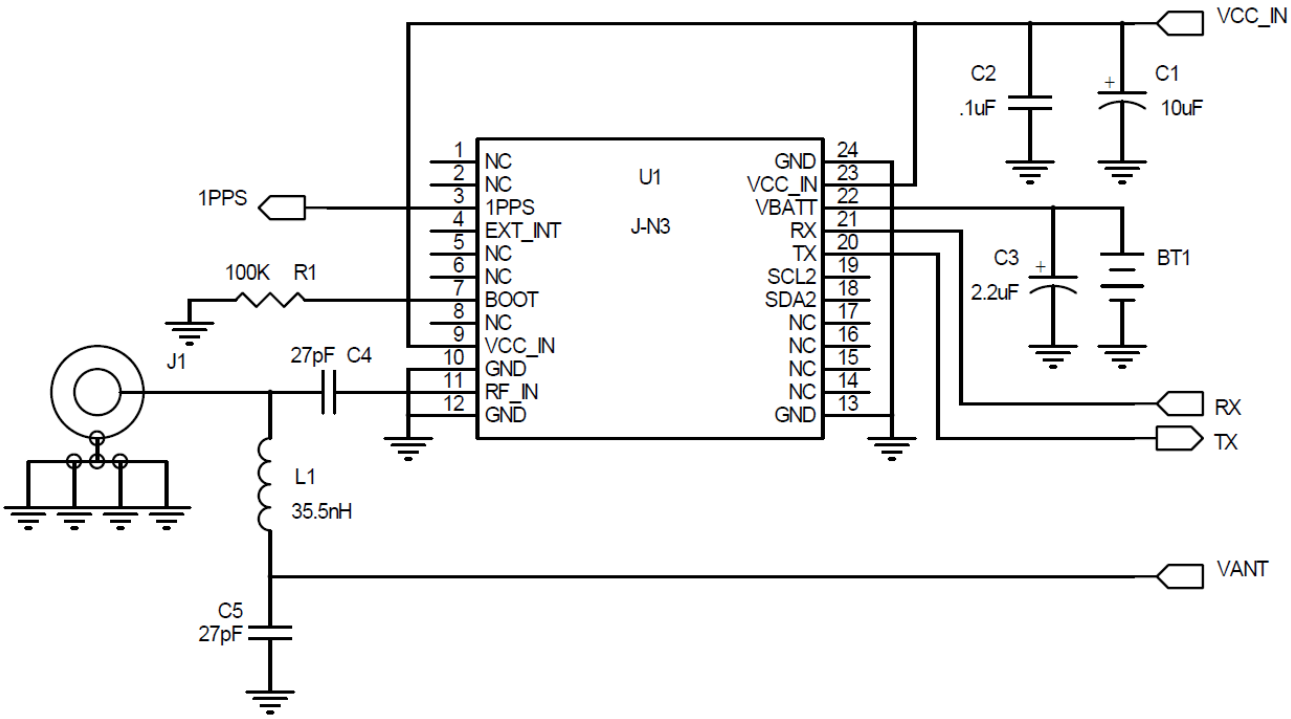

Figure 1 JN3 Reference Design

Along with power and ground, the minimum number of signals required to operate the JN3 properly are two digital signals and one RF signal.
The RF input can be connected directly to a GPS antenna. The reference design shows a DC power feed for an active antenna. C5 is used to block the DC voltage from entering the JN3. The inductor L1 is chosen to be self resonant at the GPS frequency, 1.57542 GHz, to minimize loading on the RF trace. Capacitor C6 is chosen to be self resonant at the GPS frequency such that is looks pretty close to an RF short at that frequency. V_ANT is the supply voltage for the external active antenna.
TX is the normal digital output and is a serial UART with a default bit rate of 4800 bps, 1 stop bit and 8 data bits. This is a 3.3 volt logic level signal. As is the case with all serial data, the idle state is logic one.
RX is the normal digital input and is a serial UART with a default bit rate of 4800 bps, 1 stop bit and 8 data bits. This is a 1.8 volt logic level signal, but is tolerant to 3.6 volts. As is the case with all serial data, the idle state is logic one.
Note: Connection to Boot signal is not required for EEPROM and ROM-only modules.
Note: Do not drive any of the GPIOs/Rx line HIGH while no power is applied to the module

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9. Firmware Configuration

The JN3 can be configured by means of firmware in order to fit better into the overall system. This section describes certain aspects of the receiver that can be configured.

9.1. Internal LNA

The JN3 offers two modes of operation, high gain mode and low gain mode, for the internal LNA. The high gain mode is the default mode and provides 16 to 20dB of gain. The low gain mode provides 6 to 10dB of gain.
In general, the high gain mode is intended for use with passive antennas, while the low gain mode is used when there is an external LNA as part of the RF front end (e.g. active antenna). The recommended external LNA gain is 20dB.
A version of JN3 firmware is offered for system designs that require the low LNA gain mode. The gain mode is selected by the firmware when the receiver starts up. The Tracker Config message (OSP MID178, SID2) can also be used to change the LNA mode, but note that the use of this message is not recommended, because an incorrect parameter could render the JN3 inoperable. Contact Telit technical support if this approach is required in your system.

9.2. TricklePower™ Low Power Mode

In addition to full power mode, the JN3 module can be operated in the TricklePower™ power management mode. Full power mode consumes more average power, but it is the more accurate navigation mode and supports the most dynamic motion scenarios. TricklePower mode is a duty-cycling mode. It provides navigation updates at a fixed rate and retains a high quality of GPS accuracy and dynamic motion response, but at a lower average power cost as compared to Full Power operation. TricklePower mode produces significant power savings in strong signal conditions.
Depending upon the requirements of the system design regarding frequency of position updates and availability of GPS signals in the operational environment, the designer can choose the mode that provides the better trade-off of performance versus power consumption. TricklePower mode can be commanded using the Power Mode Request Message (MID218), which is available as part of the OSP message set. This message can also be used to command the receiver back to Full Power mode. More details regarding low power operation can be found in the Low Power Operating Modes Application Note.

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9.3. Host Serial Interface

As mentioned above in Section 5, the host serial interface is a UART. The UART can operate at baud rates of 4800, 9600, 19200, 38400, 57600, 115200, 230400 and 460800 bps.

9.3.1. NMEA Protocol Considerations

The lower UART baud rates are typically used for NMEA protocol. Note should be taken however of the bandwidth limitation at 4800 baud. By default, the JN3 module communicates using NMEA at 4800 baud, with the periodic output messages limited to the GGA, GSA and RMC messages at once per second and the GSV message once every five seconds. At 9600 baud or higher, additional output messages may be enabled.
If the JN3 is operated in TricklePower mode, a baud rate of at least 38400 is recommended. This reduces the time required for data output and allows the receiver to drop into the lowest power state for a longer average time.
Use the Set Serial Port (PSRF100) NMEA command to change the baud rate. This command can also be used to switch the protocol to OSP as described in the next section. Use the Query/Rate Control (PSRF103) to enable and disable output messages and set their output rates.

9.3.2. OSP Considerations

The higher baud rates are used for OSP. OSP offers a richer set of commands and more types of data output than does NMEA. Use the Set Serial Port (PSRF100) NMEA command to switch the protocol from NMEA to OSP. The minimum recommended baud rate for OSP is 38400, provided that debug data messages are not enabled. If data debug messages are enabled, the minimum baud rate is 115200 in order to prevent data from being dropped. The protocol can be switched back to NMEA using the Switch to NMEA Protocol command (Message ID 129).

9.4. MEMS Configuration

The JN3 module interfaces to MEMS sensors using the DR I2C bus as mentioned above in Section 6. The sensors that may be connected are an accelerometer and a magnetometer, also called a digital compass.
A Sensor Configuration OSP message (Message ID 234, Sub ID 1) must be sent to the JN3 in order to configure it to interface with the connected sensor or sensors. The configuration data in this message is extensive and is described in detail in the OSP Manual. After the sensor interface has been configured, the sensors must be enabled using the Sensor Switch message (Message ID 234, Sub ID 2).
Once the sensor interface has been configured and the sensors enabled, the sensor data will be output by the JN3 in OSP Message 72, Sub ID 1. Note that a data message is output for each sensor and can contain several sets of data from the given sensor.

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9.5. Motion Dynamics

9.5.1. Static Navigation

Static navigation, also called position pinning, is a mechanism that it is used by the receiver to freeze, or pin, the position when the velocity falls below a threshold indicating that the receiver is stationary. The heading is also frozen, and the velocity is reported as 0. The solution is then unpinned when the velocity increases above a threshold or when the computed position is a set distance from the pinned position, indicating that the receiver is in motion again. Note that these velocity and distance thresholds cannot be changed.
By default static navigation is disabled. It can be enabled by sending a Static Navigation message (Message ID 143) with the static navigation flag set to 1. This feature is useful for applications in which very low dynamics are not expected, the classic example being an automotive application.

9.5.2. Velocity Dead-Reckoning

Velocity dead-reckoning refers to the use of the last known velocity to propagate the navigation solution when there are insufficient measurements to calculate an updated solution. It serves to mitigate the effects of blocked satellite signals by continuing to provide a position output. Note that the receiver outputs status information which indicates whether a solution is being maintained using dead-reckoning.
By default the receiver operates in dead-reckoning mode for up to 15 seconds before invalidating the position. This timeout value is considered to be appropriate for most applications. It can be changed using the Mode Control message (Message ID 136). Valid timeout values range from zero, which disables dead-reckoning, to two minutes.

9.5.3. MEMS Static Detection

MEMS Static Detection uses 3-axis accelerometer data to constrain position drifts and wander during stationary periods of operation.
MEMS Static Detection is an improvement over the Static Navigation method because the accuracy of the accelerometer data is not a function of the dynamics of the receivers or the signal level of the GPS satellites.

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9.5.4. MEMS Wake-up

MEMS Wake-up also uses a 3-axis accelerometer to determine if the receiver is moving or not. Currently this is only a sub-feature of MPM, not a stand-alone feature.
In this feature, an acceleration threshold is programmed into the actual sensor device. If the programmed threshold is exceeded, the interrupt output from the accelerometer device becomes active.
If MPM is in a degraded mode (lack of signal acquisition during the periodic update cycles) and the software is configured to allow sensor wakes, the MEMS Wake-up will attempt more frequent calibration cycles, under the assumption that movement of the receiver may result in different and/or better signal conditions.

9.6. Advanced Features

9.6.1. CW Jamming Detection

The JN3 module detects, tracks and removes narrow-band interfering signals (jammers) without the need for external components or tuning. It monitors a frequency band that is +/-4MHz from the L1 frequency for jammers. Any number of jammers that occur outside of a +/-1MHz center band are removed by the JN3 with a 2MHz band pass filter. Up to eight jammers inside this center band are removed using a notch filter.
Data regarding detected jammers is output using OSP messages. Message ID 92, Sub ID 1, reports up to eight of the most recently detected interferers. This feature is useful both in the design stage and during the production stage for uncovering issues related to unexpected jamming.

9.6.2. SBAS

The JN3 receiver is capable of using Satellite-Based Augmentation System (SBAS) satellites as a source of both differential corrections and satellite range measurements. These systems (WAAS, EGNOS, MSAS) use geostationary satellites to transmit regional differential corrections via a GPS-compatible signal. The use of SBAS corrections can improve typical position accuracy to 3m or less in open-sky applications.
Note that only an SBAS can be used as source of differential corrections. Other sources such as data from RTCM beacons are not supported.
By default the JN3 does not attempt to acquire SBAS satellites. This can be changed by sending in a DGPS Source command (MID 133) and specifying the source of DGPS corrections as SBAS. When the receiver acquires SBAS satellites, it will demodulate and use corrections data from the satellite signal.
The receiver can be configured to compute SBAS satellite range measurements and use them in the navigation solution. This can be enabled through a control bit in the OSP Mode Control command (MID 136). See the OSP Manual for details.

9.6.3. 2-D Acquisition

By default, the JN3 will compute a 2-D solution when possible when performing initial acquisition. In a 2-D solution, the receiver assumes a value for altitude and uses it to estimate

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the horizontal position. Under warm and hot start conditions, the receiver uses the last known value of altitude, which is a good assumption in most situations.
However under cold start conditions, the last position is unknown, and the receiver assumes a value of 0. In situations where the true altitude is significantly higher than that, the horizontal position estimate will be noticeably impacted. To accommodate applications for which these situations are a concern, a version of JN3 firmware is offered that requires a calculated altitude, i.e. a 3-D navigational solution, in order for the receiver to first enter navigation.

9.6.4. MEMS Compass Heading

The JN3 module incorporates a feature that reads and reports the compass heading from a 3-axis magnetometer. The raw heading data is used to enhance navigation performance under low speed conditions. The raw heading data is also reported over the OSP message interface. The compass heading information meets the following general performance guidelines:

- 50% Heading Accuracy 2 Deg
- 95% Heading Accuracy 5 Deg

NOTE: The magnetic compass feature and performance is affected by the magnetic environment due to magnetic anomalies. These can typically be caused by large masses of ferrous metal, such as iron, as well as natural disturbances in the earth's magnetic field. These magnetic anomalies cause errors in the sensing of the magnetic field and result in larger than specified errors.

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10. Handling and soldering

10.1. Moisture Sensitivity

The JN3 module has a moisture sensitivity level rating of 3 as defined by IPC/JEDEC J-STD-020. This rating is assigned due to some of the components used within the JN3.
The JN3 is supplied in trays or tape and reel and is hermetically sealed with desiccant and humidity indicator card. The JN3 parts must be placed and reflowed within 48 hours of first opening the hermetic seal provided the factory conditions are less than 30°C and less than 60% and the humidity indicator card indicates less than 10% relative humidity.
If the package has been opened or the humidity indicator card indicates above 10%, then the parts will need to be baked prior to reflow. The parts may be baked at +125°C ± 5°C for 48 hours. However, the trays, nor the tape and reel can withstand that temperature. Lower temperature baking is feasible if the humidity level is low and time is available. Please see IPC/JEDEC J-STD-033 for additional information.
Additional information can be found on the MSL tag affixed to the outside of the hermetical seal bag.
Note: JEDEC standards are available for free from the JEDEC website http://www.jedec.org.

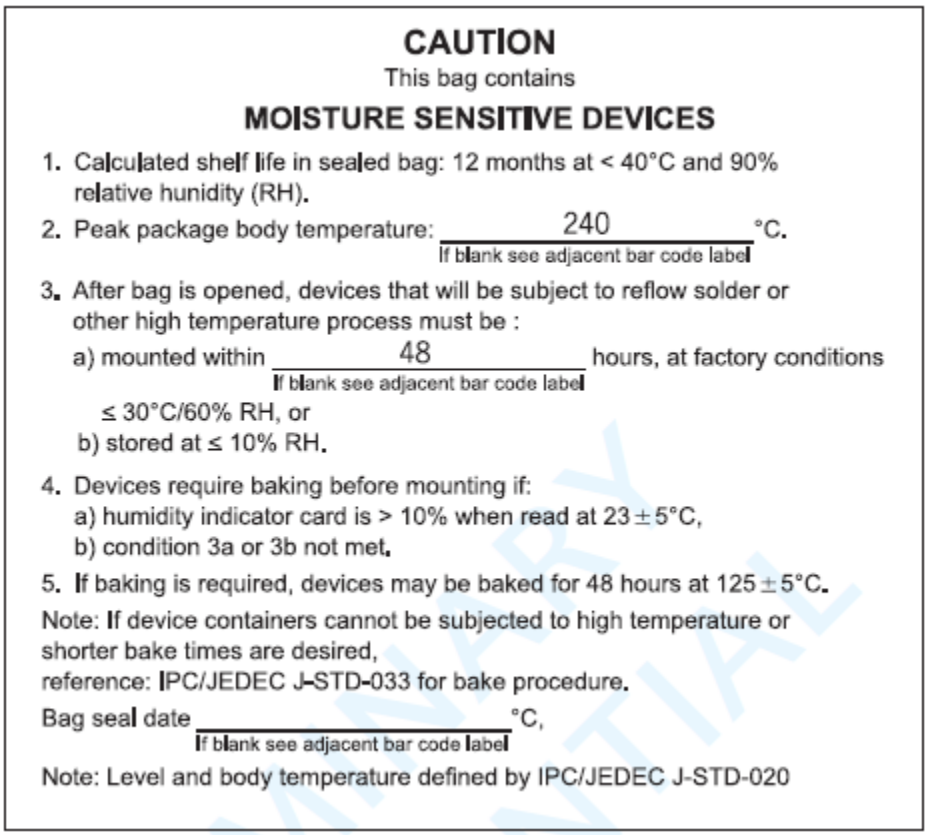
CAUTION
This bag contains
MOISTURE SENSITIVE DEVICES
1. Calculated shelf life in sealed bag: 12 months at < 40°C and 90% relative hunidity (RH).
2. Peak package body temperature: 240 °C.
If blank see adjacent bar code label
3. After bag is opened, devices that will be subject to reflow solder or other high temperature process must be :
a) mounted within 48 hours, at factory conditions
If blank see adjacent bar code label
≤ 30°C/60% RH, or
b) stored at ≤ 10% RH.
4. Devices require baking before mounting if:
a) humidity indicator card is > 10% when read at 23±5°C,
b) condition 3a or 3b not met.
5. If baking is required, devices may be baked for 48 hours at 125±5°C.
Note: If device containers cannot be subjected to high temperature or shorter bake times are desired,
reference: IPC/JEDEC J-STD-033 for bake procedure.
Bag seal date °C,
If blank see adjacent bar code label
Note: Level and body temperature defined by IPC/JEDEC J-STD-020

Figure 2 – Label for Moisture Sensitive Devices

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10.2. ESD

The JN3 is an electrostatic discharge sensitive device and should be handled in accordance with JESD625-A requirements for Handling Electrostatic Discharge Sensitive (ESDS) Devices. Although the JN3 is a module, the expecting handling of the JN3 during assembly and test is identical to that of a semiconductor device.
Note: JEDEC standards are available for free from the JEDEC website http://www.jedec.org.

10.3. Reflow

The JN3 is compatible with lead free soldering processes as defined in IPC/JEDEC J-STD-020. The reflow profile must not exceed the profile given IPC/JEDEC J-STD-020 Table 5-2, "Classification Reflow Profiles". Although IPC/JEDEC J-STD-020 allows for three reflows, the assembly process for the JN3 uses one of those profiles. Thus the JN3 is limited to two reflows.
Note: JEDEC standards are available for free from the JEDEC website http://www.jedec.org.
When reflowing a dual-sided SMT board, it is important to reflow the side containing the JN3 module last. This prevents heavier components within the JN3 becoming dislodged if the solder reaches liquidus temperature while the module is inverted.

10.4. Assembly Issues

Due to the piezo-electric components within the JN3, the component should be placed close to the end of the assembly process to minimize shock to the module. During board singulation, pay careful attention to unwanted vibrations and resonances introduced into the board assembly by the board router.

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11. PCB Layout Details

The PCB footprint on the receiving board should match the JN3 pad design shown below.
The solder mask opening is generally determined by the component geometry of other parts on the board and can be followed here.
Standard industry practice is to use a paste mask stencil opening the same dimensions as the pad design.
All dimensions shown are in mm.

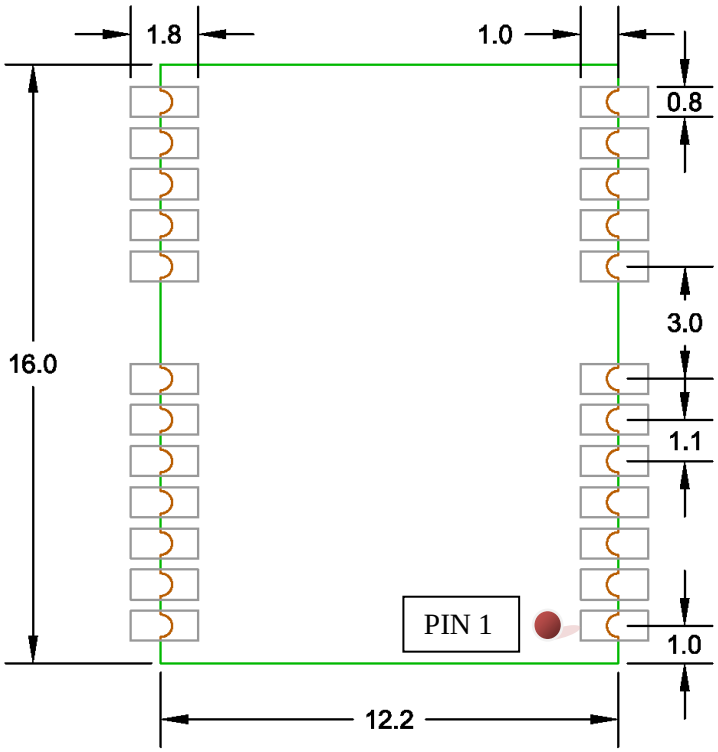

Figure 3 – JN3 Pad Design (TOP View)

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12. Safety Recommendations

READ CAREFULLY

Be sure the use of this product is allowed in the country and in the environment required. The use of this product may be dangerous and has to be avoided in the following areas:

- Where it can interfere with other electronic devices in environments such as hospitals, airports, aircrafts, etc.
- Where there is risk of explosion such as gasoline stations, oil refineries, etc. It is responsibility of the user to enforce the country regulation and the specific environment regulation.

Do not disassemble the product; any mark of tampering will compromise the warranty validity. We recommend following the instructions of the hardware user guides for a correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conforming to the security and fire prevention regulations. The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.
The system integrator is responsible of the functioning of the final product; therefore, care has to be taken to the external components of the module, as well as of any project or installation issue, because the risk of disturbing the GSM network or external devices or having impact on the security. Should there be any doubt, please refer to the technical documentation and the regulations in force. Every module has to be equipped with a proper antenna with specific characteristics. The antenna has
to be installed with care in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (20 cm). In case of this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

The European Community provides some Directives for the electronic equipments introduced on the market. All the relevant information's are available on the European Community website:

http://ec.europa.eu/enterprise/sectors/rtte/documents/

The text of the Directive 99/05 regarding telecommunication equipments is available, while the applicable Directives (Low Voltage and EMC) are available at:

http://ec.europa.eu/enterprise/sectors/electrical/

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13. Document History

Revision	Date	Changes
0	2012-01-20	First issue
1	2012-05-04	Updated Figure 1
2	2012-08-06	Updated Figure 3, main serial port section and mems section

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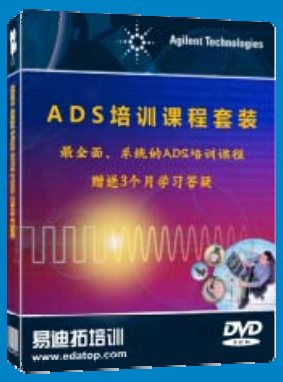

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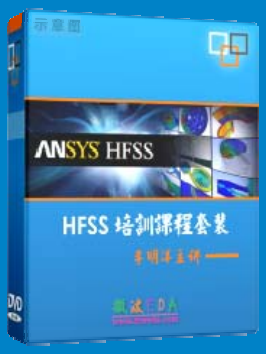

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